

Laser Assisted Particle Removal

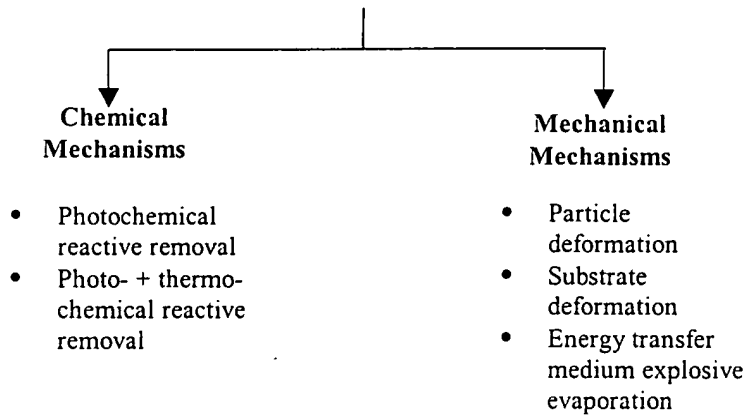


Fig. 1

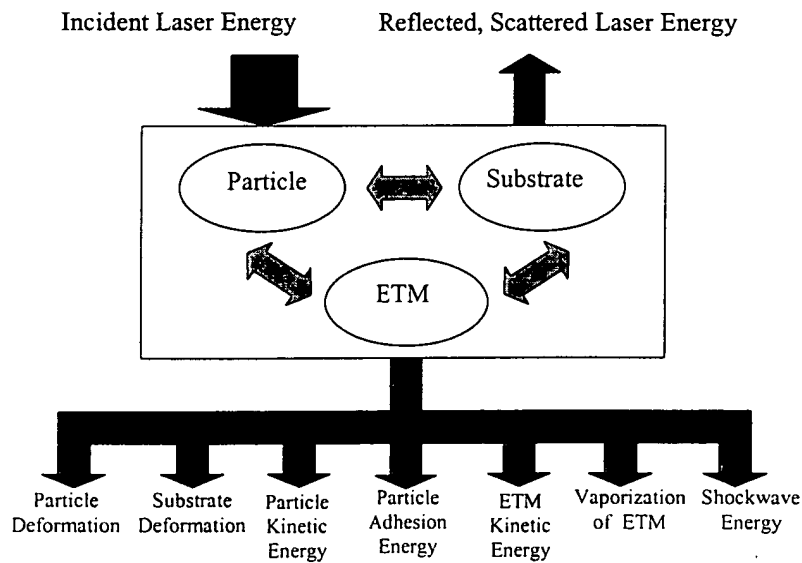


Fig. 2

Absorption Medium	Particle	ETM	Substrate with ETM	Substrate without ETM
Removal Mechanism	Rapid thermal expansion of particle	Explosive evaporation of ETM	Microbubble formation at liquid/solid interface	Rapid thermal expansion of the substrate
wavelength	$\lambda \ll \text{Particle Diameter}$	$\lambda \gg \text{Particle Diameter}$	$\lambda > \text{Particle Diameter}$	$\lambda \gg \text{Particle Diameter}$ or $\lambda < \text{Particle Diameter}$ if α_{particle} is low
Energy Absorption	$\alpha_{\text{particle}} \gg \alpha_{\text{substrate}}$	High α_{ETM}	High $\alpha_{\text{substrate}}$	High $\alpha_{\text{substrate}}$
Substrate Damage	-Melting/Ablation of particle	Shockwave, substrate absorption	-Melting/Ablation of particle or substrate -Shockwave in ETM	Melting/Ablation of particle or substrate
Particle Removal Threshold	$\Phi_{\text{th}}=0.01-0.08 \text{ J/cm}^2$ $I_{\text{th}}=1-11 \text{ MW/cm}^2$ $D=20 \mu\text{m}$	$\Phi_{\text{th}}=0.65-2.2 \text{ J/cm}^2$ $I_{\text{th}}=3-11 \text{ MW/cm}^2$	$\Phi_{\text{th}}=0.02-0.3 \text{ J/cm}^2$ $I_{\text{th}}=2-600 \text{ MW/cm}^2$ $\tau=0.03-20 \text{ ns}$	$\Phi_{\text{th}}=0.02-0.3 \text{ J/cm}^2$ $I_{\text{th}}=1-30 \text{ MW/cm}^2$ $\tau=7-30 \text{ ns}$

Fig. 3

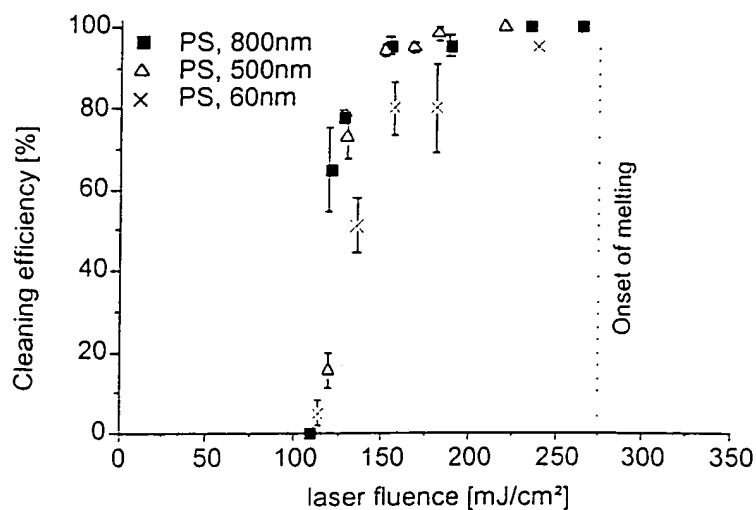


Fig. 4

FIG. 5

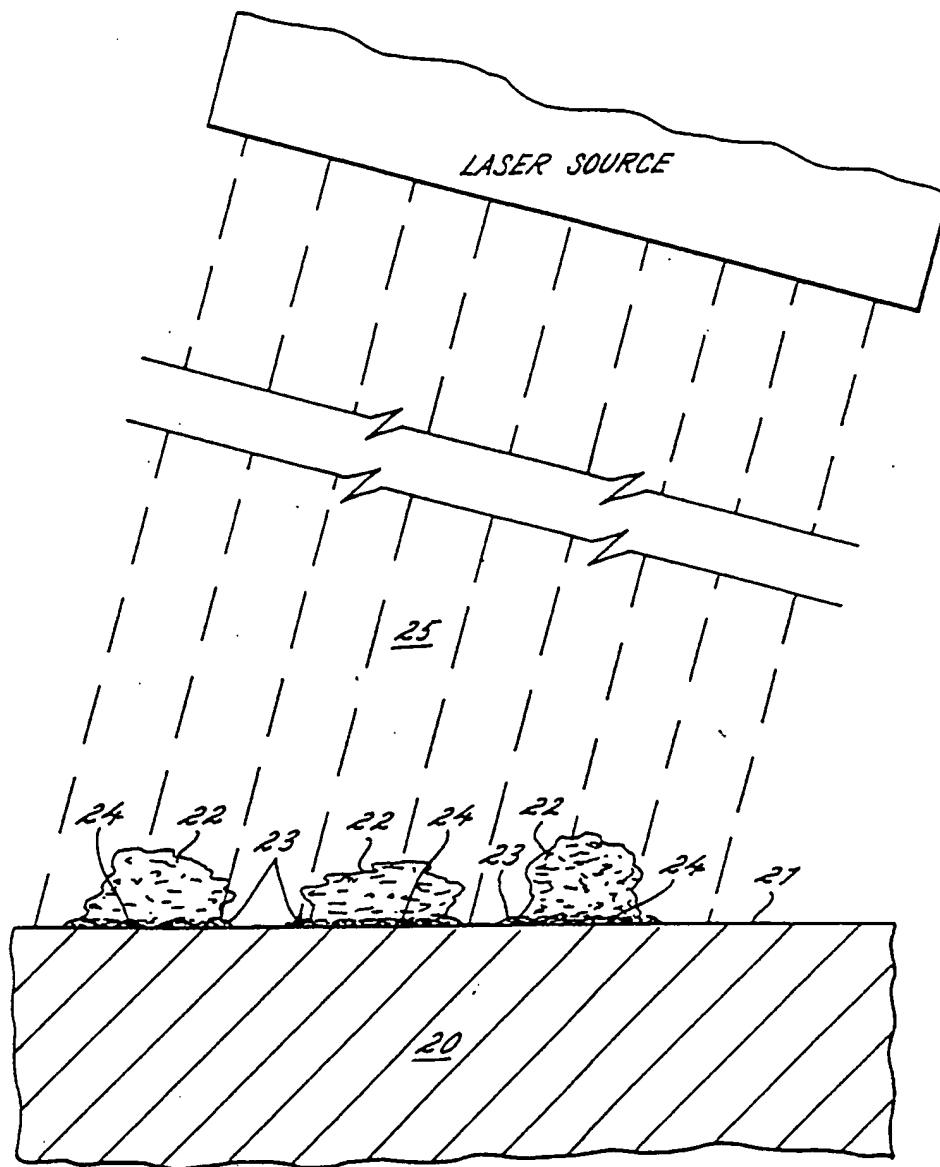


FIG. 5

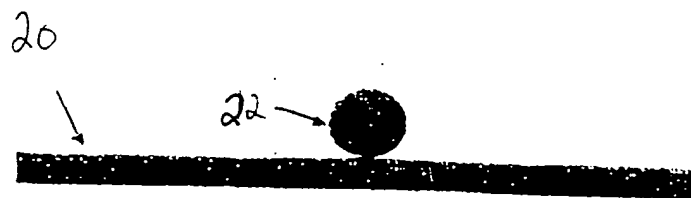


Fig. 6A

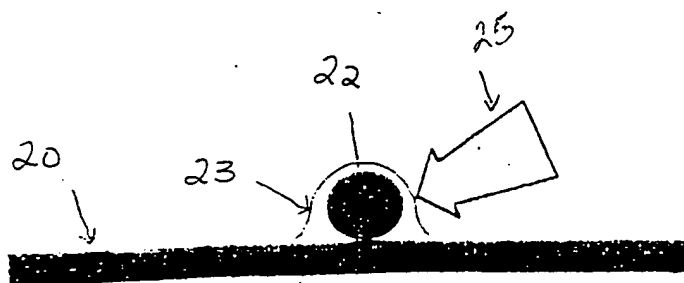


Fig. 6B

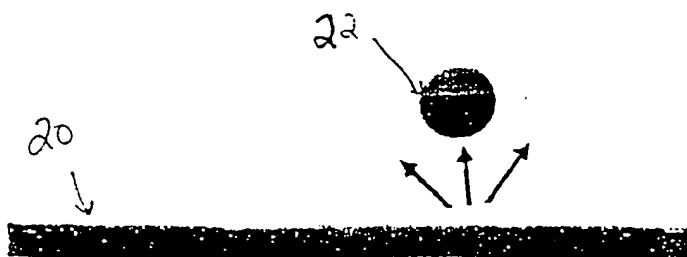


Fig. 6c

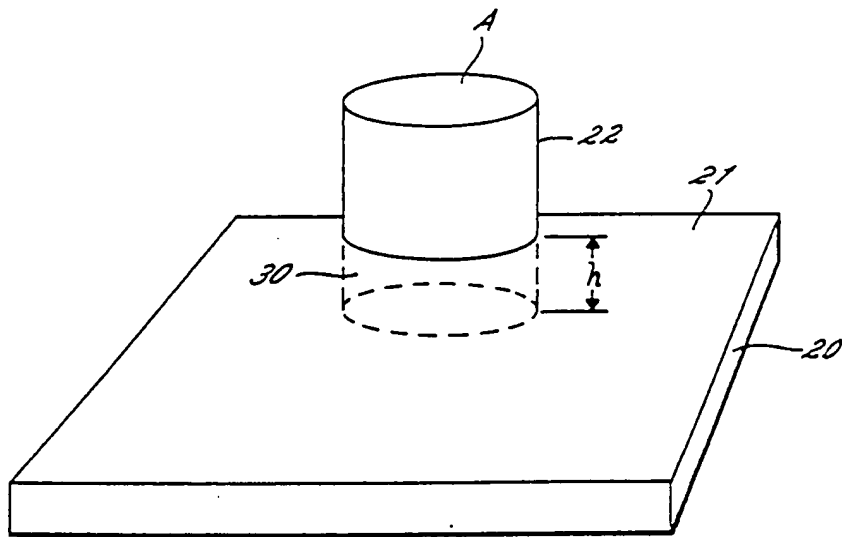


FIG. 7

FIG. 7

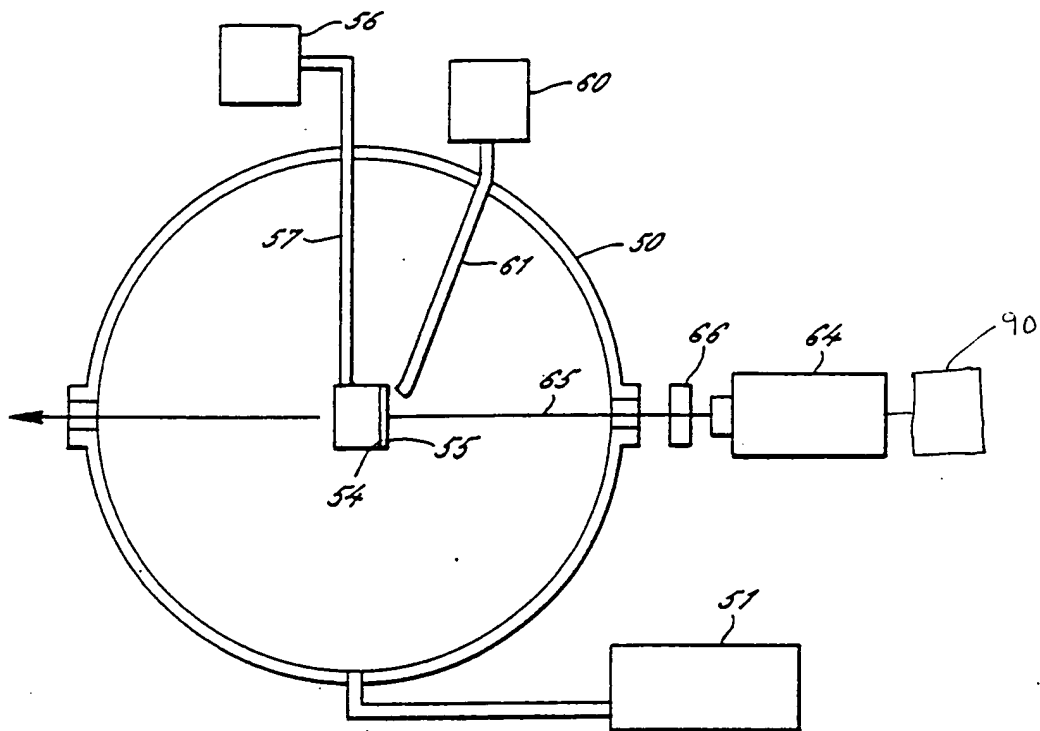


FIG. 8

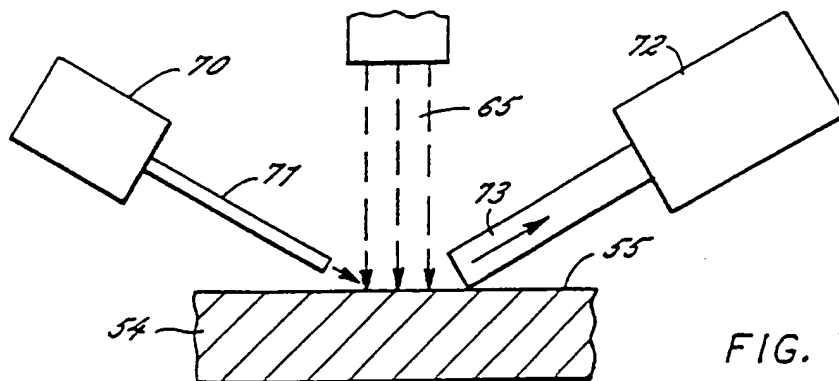


FIG. 9

Figure 10

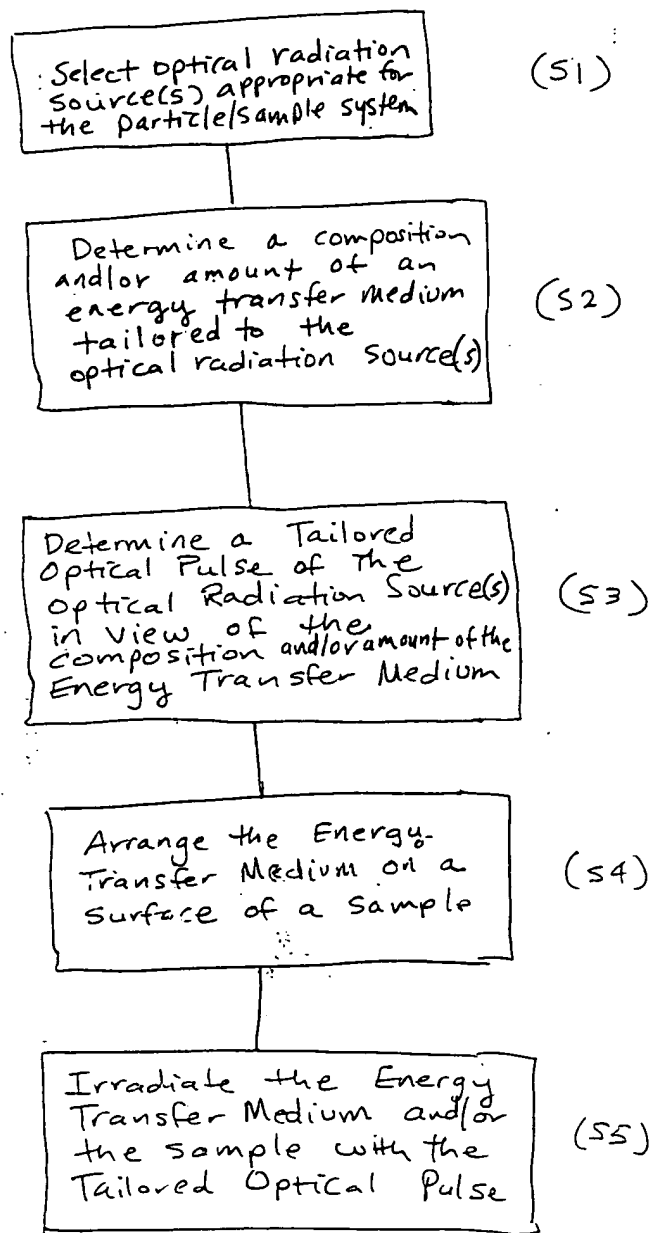


FIG. 11

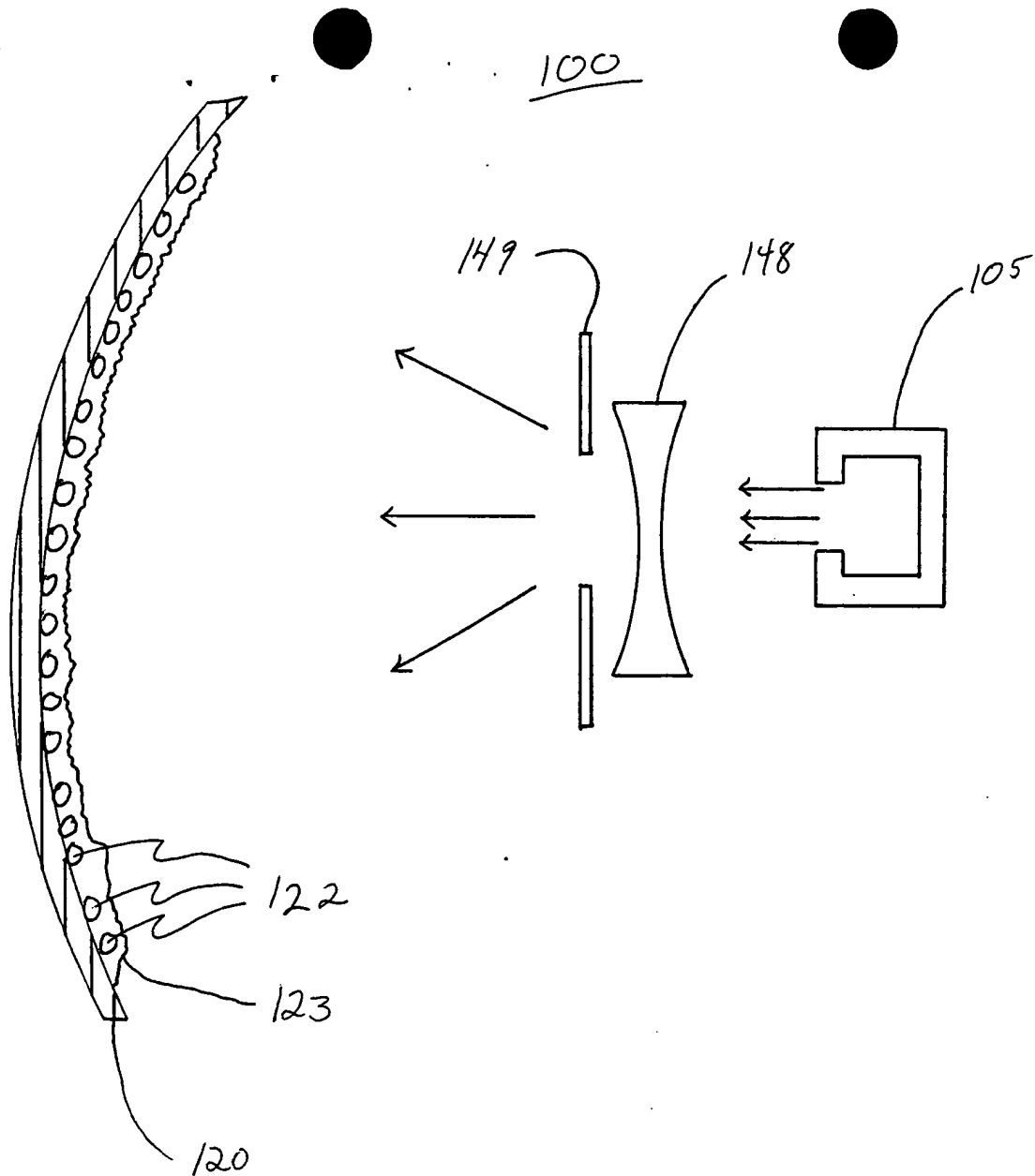


Fig. 11

FIG. 12

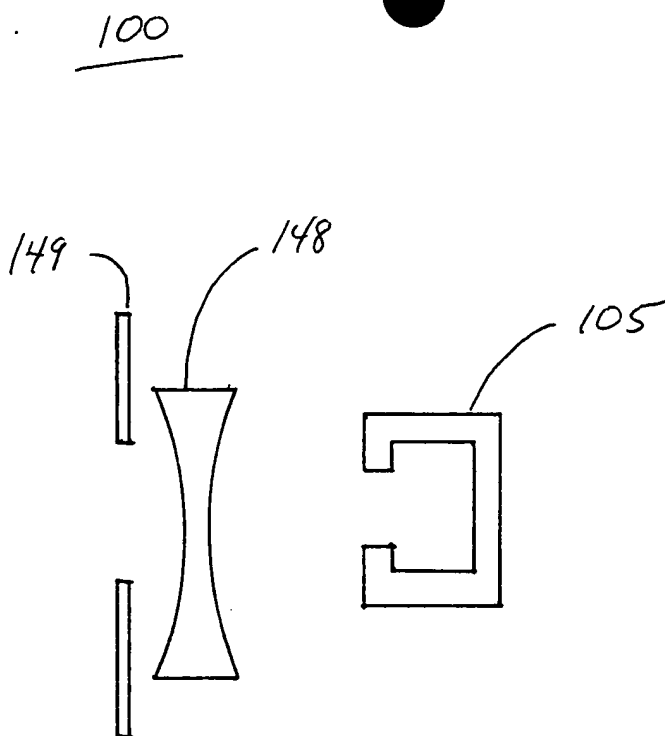
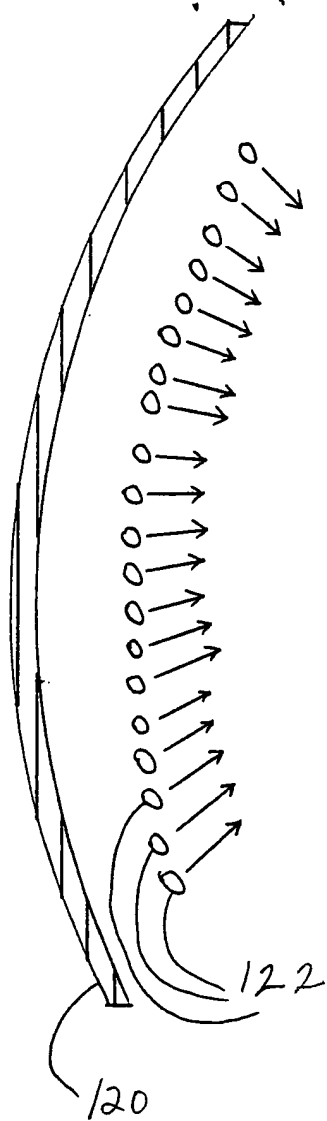


Fig 12

200

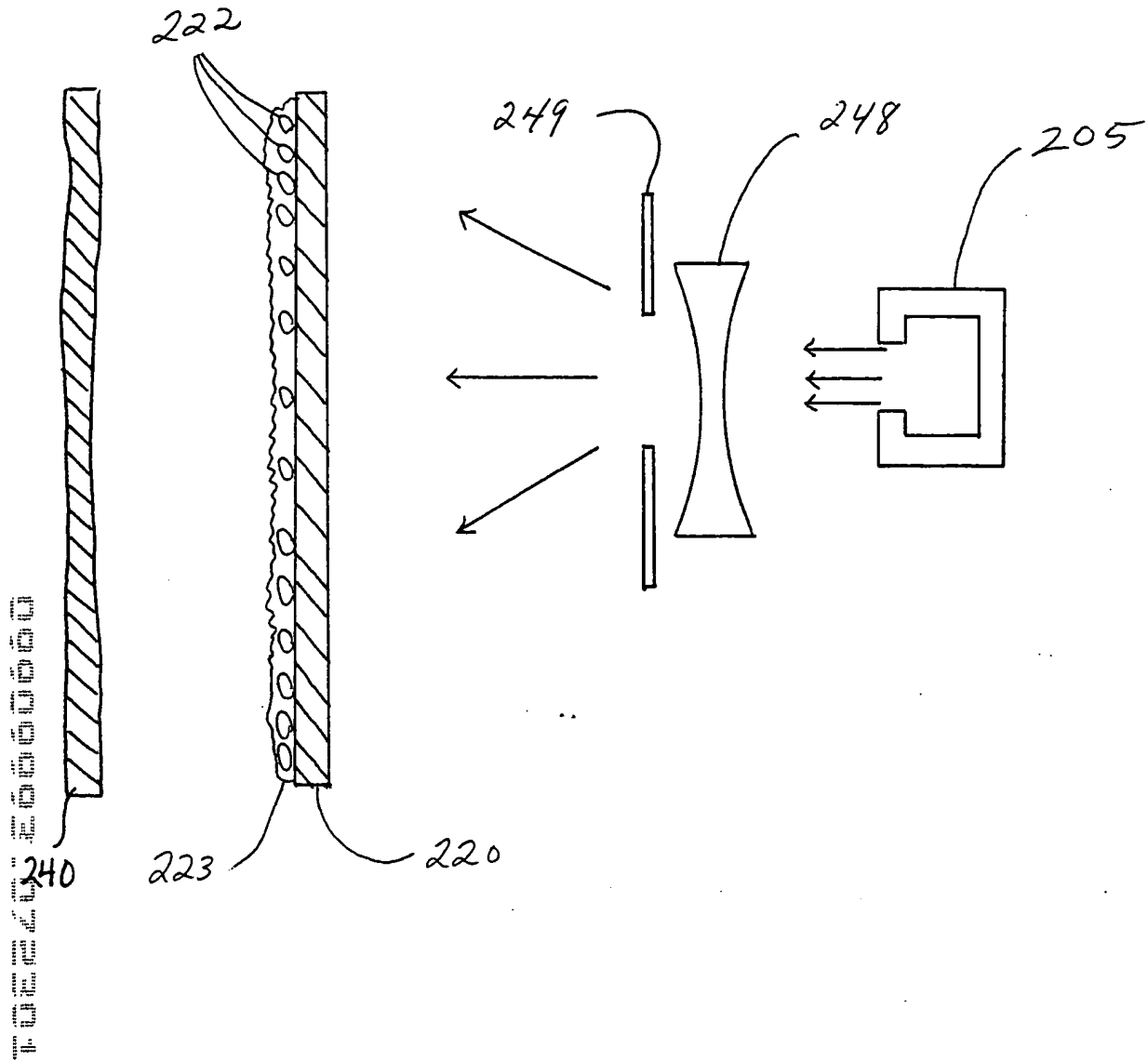


Fig 13